

Reactor Refueling System Conceptual Design for Integral Reactor

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1. Introduction

Fuel handling system means the integral system including relevant equipments, tools and correspond processes from reception of new fuel channels to shipment of spent fuel channels within the spent fuel shipping cask. Fuel handling system consists of fresh fuel handling and storage system, spent fuel handling and storage system, refueling system, and fuel transfer mechanism. Fuel channels are handled in the water for general nuclear reactors. Spent fuel channels are extracted from the reactor core in the refueling water after reactor shutdown and delivered to the spent fuel storage rack through fuel transfer mechanism in the water. Also fresh fuel channels are handled and inserted in the core in the reverse direction under the water. To handle the fuel channels in the water, there are refueling pool in the reactor building, fuel transfer mechanism between the reactor building and the compound building, and refueling canal in the compound building. The developing integral reactor has its own reactor characteristics such as operating mode, fuel characteristics, and so on. So it has different design of fuel handling system, especially it has no refueling pool in the reactor building.

Recently small-to-medium size multi-purpose advanced reactor draws major attention because of its space advantages, adaptive nature, diversity of application, simplicity of reactor system, and passive safety approach. The fueling handling system for this integral reactor also needs to be developed to enlarge its merits and to increase nuclear safety. The design concepts of refueling system for the integral reactor are presented in this paper.

2. Design characteristic of Refueling system

The integral reactor has a steam generator, a pressurizer, control element drive mechanisms, and main coolant pumps on the reactor vessel without any external piping. Upper structures of the reactor including the pressurizer are removed by the reactor servicing equipments for refueling, however main coolant pumps still remain on the reactor. It makes difficult to submerge the reactor during refueling. Therefore refueling insulation tank is introduced for refueling system. It is installed on the reactor and filled with refueling water to reduce irradiation to worker [1]. The refueling machine extracts spent fuel channel from the reactor core or inserts fresh fuel channel into the core. Refueling tube with gripper gets down on the reactor core (2 position in Figure 1), and grips the fuel

head and extracts the fuel channel. Refueling tube with spent fuel channel gets up into the refueling cask and the gate valve is closed for transporting. So water is

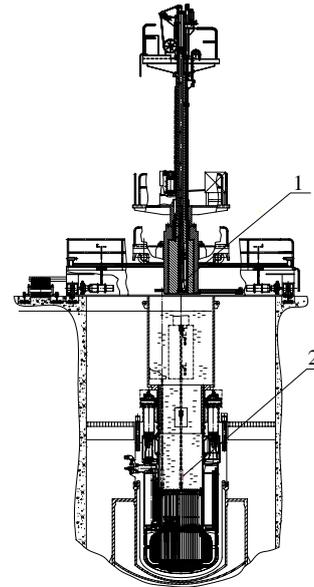


Figure 1. The refueling machine installed on the reactor core for fuel insertion or extraction

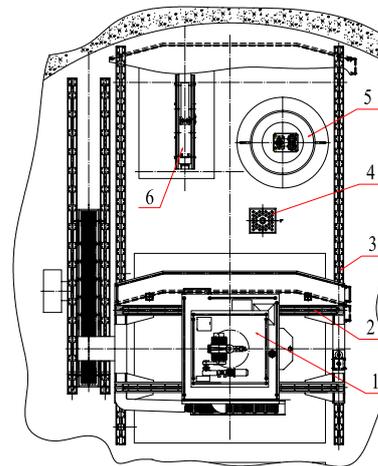


Figure 2. The refueling system arrangement in the reactor building

- 1) Refueling machine
- 2) Refueling machine carriage rail
- 3) Refueling machine bridge rail
- 4) Fresh fuel transport casing installation platform
- 5) Facility for refueling machine preparation
- 6) Fuel transfer mechanism

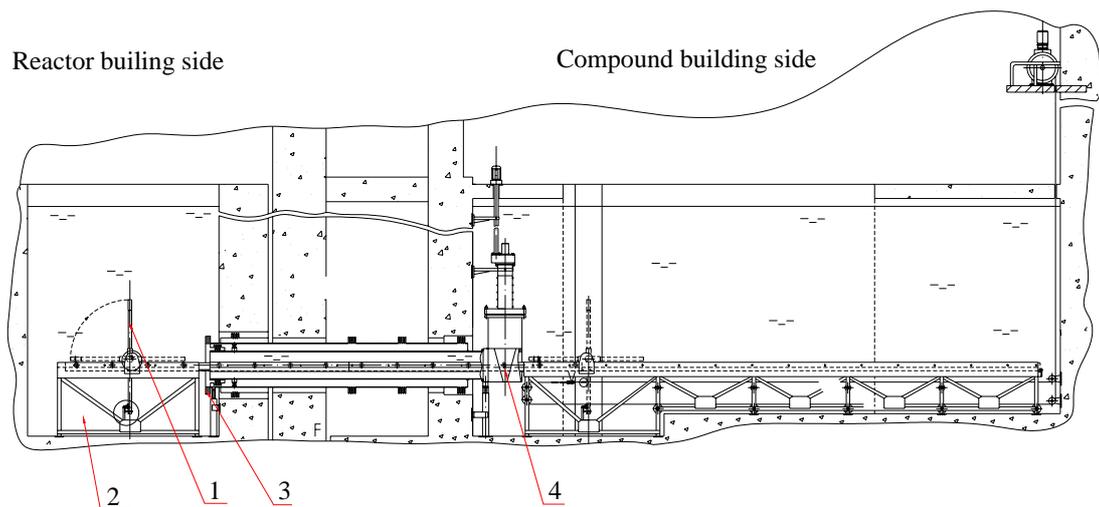


Figure 3. Fuel transfer mechanism concepts

- 1) Fuel transfer mechanism seat
- 3) Blind flange

- 2) Upender
- 4) Fuel transfer mechanism gate valve

captured in the refueling cask and it works as coolant and insulator.

When it extracts spent fuel channel, it moves to the fuel transfer mechanism seat along the refueling machine carriage rail and bridge rail arranged as shown in Figure 2. During transportation, refueling cask prevents excessive irradiation and overheating of spent fuel channel. Coolant water is filled inside of the refueling cask, and in case of emergency there is auxiliary water tank for refilling [2].

Fresh fuel channels are prepared for refueling in fresh fuel transport casing which is installed in the fresh fuel transport casing installation platform in the reactor building. The refueling machine grips and extracts fresh fuel channel from it and moves above the reactor core.

After refueling, refueling insulation tank is removed and transported to facility for refueling machine preparation.

2. Design characteristic of Fuel Transfer Mechanism

Fuel transfer mechanism is designed to transfer a spent fuel channel between the reactor building and the compound building. This is not used for fresh fuel channels. Fresh fuel channels are transported by fresh fuel transport casing through the equipment hatch in dry condition. The refueling machine transfers fuel channel to the fuel transfer mechanism seat (position 1 in Figure 3) and the carriage delivers it to the compound building.

Blind flange and fuel transfer mechanism gate valve have same configuration as commercial nuclear reactor, but each equipment has unique design.

3. Conclusions

Conceptual design result for refueling and fuel transfer system of the integral reactor is introduced. Each system and its equipment has its own design characteristics and unique design features. Their performance shall be verified in detail.

4. Acknowledgement

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